Enabling Large-body Active Debris Removal, Phase II

Completed Technology Project (2013 - 2015)

Project Introduction

Research suggests that: (1) orbital debris has reached the point that, even with no future launches, collisions among large-body debris will lead to unstable growth in debris, and (2) removing as few as five large objects each year can stabilize debris growth. For large-body active debris removal (LB-ADR), new technologies are required to safely capture the target debris. The interactions of these complex electromechanical systems (eg. imaging systems, robotic arms and grippers) and controllers pose challenges best addressed by hardware-in-the-loop (HWIL) testing. Given the risks inherent in non-cooperative spacecraft proximity operations and the firm requirement that ADR missions do not themselves produce additional debris, realistic ground-based testing is required for risk reduction. Our approach to HWIL contains two major advancements: (1) novel robotic technologies that overcome the limitations of existing test facilities, and (2) carefully designed spacecraft models capable of thoroughly evaluating every aspect of a capture system. The LASR Lab was built around HOMER, an omnidirectional robot designed and built specifically to emulate the 6-DOF relative-motion trajectories of spacecraft. The Phase I effort validated HOMER's capabilities and reduced to hardware the Dynamic Payload Pendulum (DPP), an actively controlled pendulum that provides the equivalent of a 5-DOF air-bearing. Together, they permit large-scale motion with accurate contact dynamics. Having identified rocket boosters as ideal LB-ADR targets, we investigated the model features necessary for realistic testing of grappling and sensing systems and for accurate dynamic response on the DPP. Leveraging the developments of Phase I and concurrent work on autonomous, vision-based navigation systems at the LASR Lab, we propose to simultaneously advance the TRL of the ground-test facility and the nav systems by performing an end-to-end simulation of an approach and capture of multiple rocket bodies.

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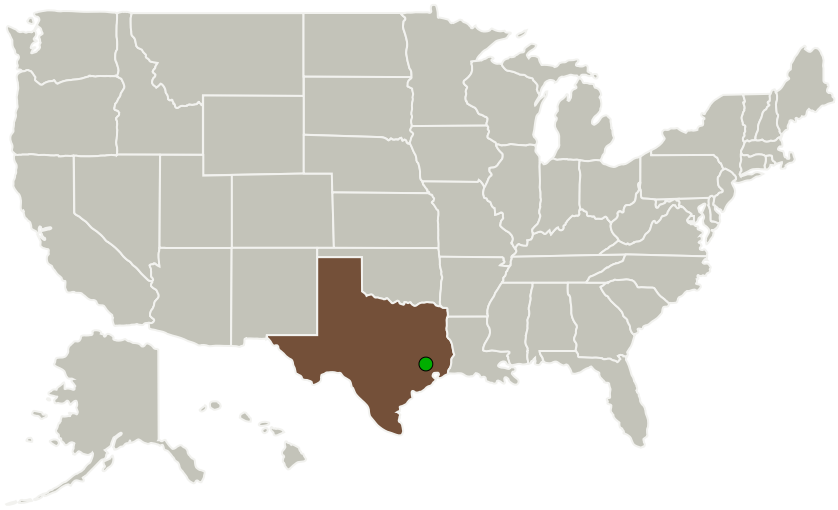
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
VectorNav Technologies, LLC	Lead Organization	Industry	Richardson, Texas
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
Texas A & M University-College Station(Texas A&M)	Supporting Organization	Academia	College Station, Texas
Texas A&M Engineering Experiment Station(TEES)	Supporting Organization	Academia	College Station, Texas

Primary U.S. Work Locations
Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

VectorNav Technologies, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

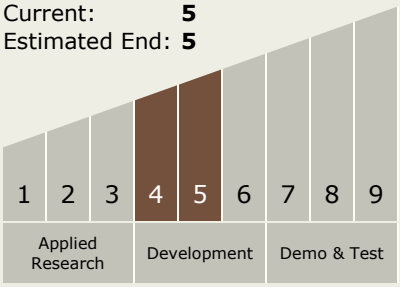
Carlos Torrez

Principal Investigator:

John Hurtado L Hurtado

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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Project Transitions

July 2013: Project Start

July 2015: Closed out

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.5 Autonomous Rendezvous and Docking
    - TX04.5.4 Capture Sensors

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System